Report for 2004ID25B: Advanced Cone Penetrometer Technology for In-Situ Measurement of Unsaturated Soil Hydraulic Properties

There are no reported publications resulting from this project.

Report Follows

Final Report Synopsis

Title: Advanced Cone Penetrometer Technology for In-Situ Measurement of Unsaturated Soil Hydraulic Properties
Project Number: 2004ID25B
Start Date/End Date: 3/1/04 - 2/28/05
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Primary PI: Molly M. Gribb, Boise State University
Project class: Research

Most groundwater contamination originates at or near the surface of the soil, where soil is often unsaturated. As a result, understanding the hydraulic properties of unsaturated soils is necessary for predicting the movement of water and water-borne contaminants to the groundwater below. Conventional field test methods for determining the hydraulic properties of unsaturated soils are commonly limited in depth of application, and can be time consuming and labor intensive. In many cases, laboratory tests do not adequately reflect the in-situ behavior of the soil, due to the small sample size and/or disturbance of the soil structure that occurs during sampling. The aim of this project was to continue development of a cone penetrometer tool, called a cone permeameter for determining unsaturated soil hydraulic properties in situ.

Project activities began with experiments to calibrate and validate a newly fabricated prototype cone permeameter. These early experiments exposed serious design flaws that rendered the prototype unusable. As a result, a total redesign of the device was initiated. The schematic in Fig.1 shows the components of the new permeameter. The modular design allows for rapid replacement of individual components, including the cone tip, which is most susceptible to damage during use. A new prototype will be fabricated according to this design in summer 2005. Project activities also included determining the soil-water characteristic curves for an indoor meso-scale soil test bed as shown in Figs. 2 and 3, which will ultimately be used to validate the cone permeameter and other soils instrumentation. The 1.8-m

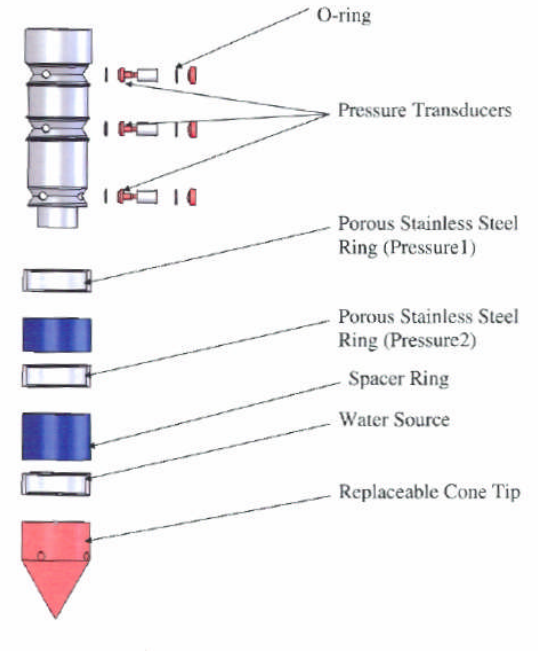

Fig. 1. New cone permeameter design schematic.

diameter by 2.1-m deep test bed was constructed in an in-ground, waterproof, concrete vault and instrumented with time domain reflectometry (TDR) waveguides and tensiometers during construction to allow for continuous measurement of soil-water content and pressure at various depths.

Fig. 2. Construction of the soil test bed and placement of tensiometers and TDR waveguides.

Data collected during wetting and drying experiments in the deposit were collected and fitted to the van Genuchten equation to determine variations in the soil-water characteristics with depth, as shown in Fig. 4. Results indicate that the bulk hydraulic properties of the soil pit change with depth, as expected. The soil-water characteristic curves have steeper slopes closer to the bottom of the deposit, likely due to the greater compaction of the lower soil layers.

In summary, testing of a prototype permeameter resulted in a total redesign of the device, which will be refabricated this summer. The soil-water characteristic curves were determined at various depths in the meso-scale soil test bed and results will be used to support undergraduate and graduate teaching, as well as provide a means for validating the performance of a new cone permeameter device as well as other soil testing equipment in the future.

Publications: A poster presentation of this work is planned at the upcoming Idaho Water Symposium. Student support: Grant funds were used to partially support two undergraduates and one graduate student. Information transfer: The meso-scale test bed and results of this work was featured in a poster presentation during the College of Engineering open house in February, 2005.

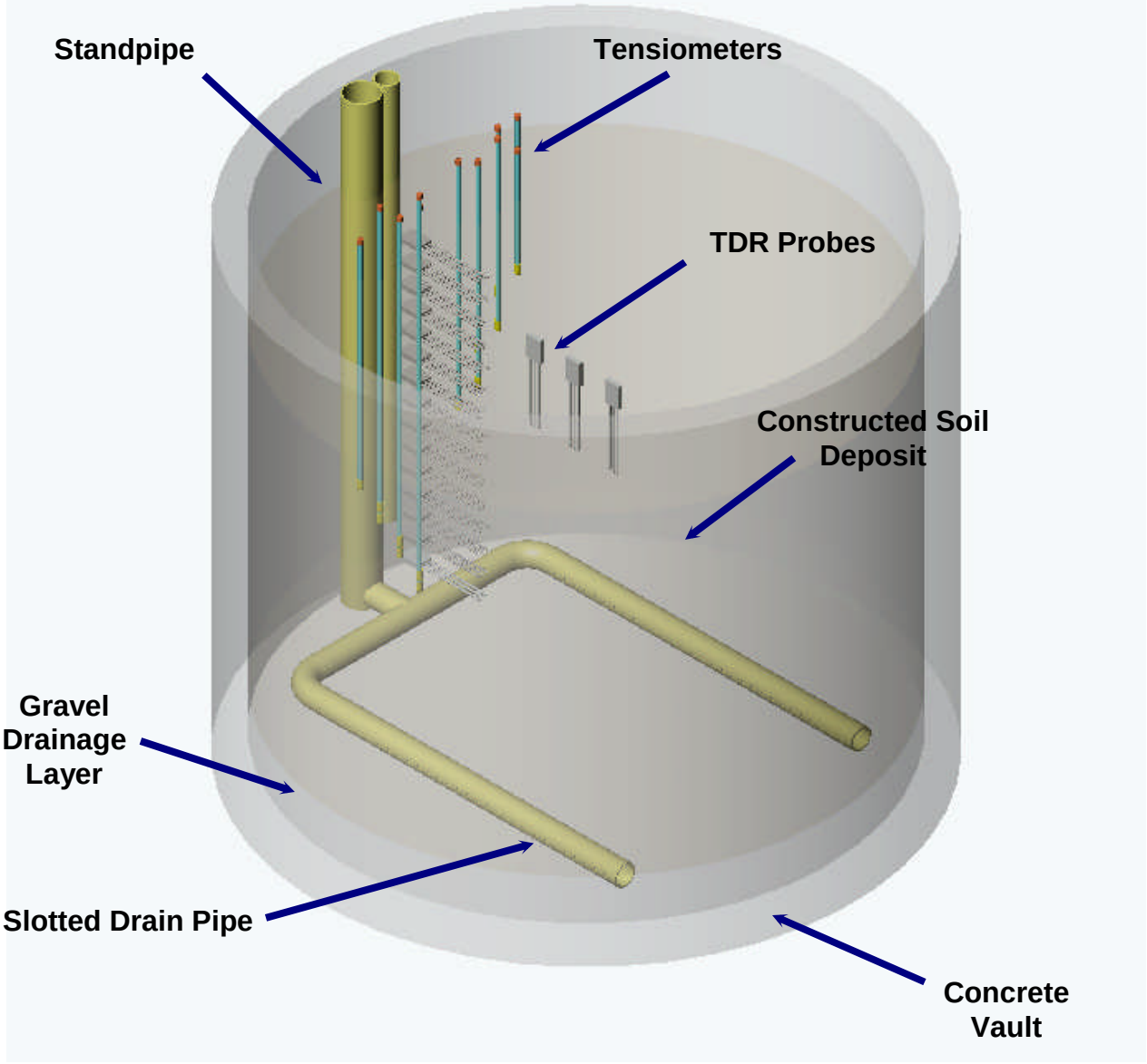

Fig. 1 Schematic of the meso-scale soil test bed.

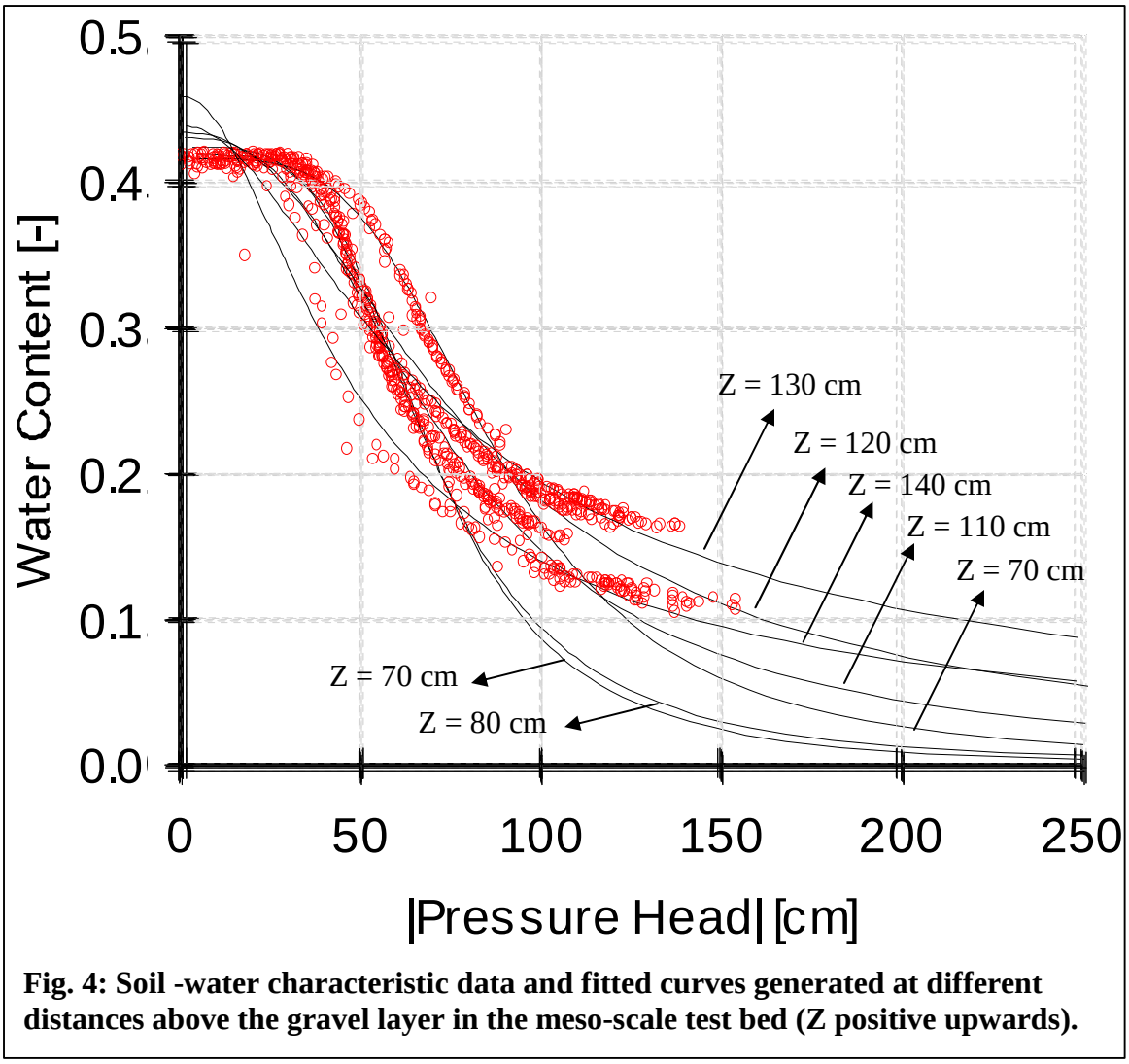

Fig. 4: Soil -water characteristic data and fitted curves generated at different distances above the gravel layer in the meso-scale test bed (Z positive upwards).